

FCC MAIL SECTION

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Federal Communications Commission
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LESLIE A. TAYLOR
President

CC
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Ms. Donna Searcy
Secretary
Federal Communications Commission
1919 M Street, N.W.
Room 222
Washington, D.C. /20554

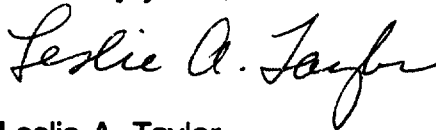
Re: RM-7511; Petition of Norris Satellite Communications, Inc. to Create a General
Satellite Service in the Ka-band

Dear Ms. Searcy:

Attached are an original and four copies of an addendum to the comments of Norris
Satellite Communications, Inc., with regard to the above rulemaking. These materials
were not available prior to today.

Please contact the undersigned if you have any questions concerning this matter.

Sincerely yours,



Leslie A. Taylor

cc: Thomas Stanley
Chief, Office of Engineering & Technology

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CCIR Fact Sheet

NOV 20 1990

Federal Communications Commission
Office of the Secretary

Study Group: IWP 4/1-USA-5

Date: 1 November 1990

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Document Title: Definition of a General Satellite Service (GSS)
To Operate in the 20/30 GHz Bands

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Purpose/Objective: The purpose of this contribution is to propose the adoption of a definition for a new space service--the General Satellite Service. Such a service, which could be accommodated in the 30/20 GHz frequency band, would enable satellite communications to be provided from the same spacecraft, and in the same frequency band, to a variety of user terminals. These terminals would be capable of fixed, mobile and/or point-to-multipoint operations. The objective of creating such a new space service is to encourage development of new frequency bands, such as the 20/30 GHz band, and to accommodate a variety of user needs.

Abstract: The document provides definitions for a General Satellite Service as well as the factors which support the need for such a service. In addition, the document discusses the feasibility of adopting the General Satellite Services in the 20/30 GHz band. An example system, the Personal Access Satellite System (PASS), which could be implemented in a flexible service such as the GSS, is described in Annex 1.

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Documents
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DEFINITION OF A GENERAL SATELLITE SERVICE (GSS)
TO OPERATE IN THE 20/30 GHz BANDS

1. INTRODUCTION

As technology evolves toward digital satellite communications and earth stations become increasingly smaller, allocations based on current satellite service definitions are artificial. Such artificial distinctions between services may retard development of new frequency bands such as the Ka-band. The development of a new satellite service definition, to be applied to a currently little-used band, will encourage the development of innovative uses of that band on a near-term basis.

Adoption of a definition for a General Satellite Service (GSS) and its use in conjunction with specified frequency bands would enable a satellite operator to serve a variety of user terminals, supporting a variety of telecommunications functions, from the same spacecraft and within the same frequency band.

There is currently rapid growth in development of new, low to medium rate, digital communications satellite services including the conversion of formerly analog voice services to digital. The user terminals for these services are becoming very small, which is a natural consequence of the evolution of key telecommunications hardware technologies. These new terminals are being used in fixed, mobile, and point-to-multipoint applications.

In some cases, it is challenging to determine in which service a particular application falls. In other cases, use of a common satellite to provide several services in the same frequency band is thwarted by the limitations of existing allocations. In still other instances satellite design may be unduly complicated by the need to operate in separate frequency bands in order to provide multiple services from the same satellite. Coordination of satellites providing several services in disparate frequency bands is difficult and orbit/spectrum efficiency can suffer.

The technical and operational problems encountered by multi-function satellites result from a lack of agreed upon sharing criteria for the satellite service they provide. Such sharing criteria would recognize that permissible use of a given frequency band can be determined by conformance to technical parameters rather than to a service definition.

Allocations to a GSS could be considered at the WARC 92 pursuant to Resolves 2.2.1 of the Agenda approved by the ITU Administrative Council, Geneva, June 11-12, 1990. Resolves 2.2.1 provides for the consideration of definitions and allocations to new space services above 20 GHz. This Agenda provision was adopted pursuant to Resolution No. PL-B/1, approved at the 1989 ITU Plenipotentiary Conference (Nice). Also relevant is WARC-ORB-88 Recommendation No. 715, which recognized the "economic and practical reasons" for "multiservice satellite networks using the geostationary-satellite orbit (for example: fixed-satellite, broadcasting-satellite and mobile-satellite services)", and invited the Administrative Council to place this matter on the agenda of a competent World Administrative Radio Conference.

2. SERVICE OBJECTIVES

Service objectives for the GSS are to provide for operation of terminals in fixed, mobile and point to multi-point applications in a common frequency band. This section describes the needs and markets for GSS terminals.

GSS terminals may be fixed, transportable, mobile, micro or personal in operation. Consider, for example, a satellite terminal with a conformal microwave monolithic integrated circuit (MMIC)-based antenna, and a send/receive data rate of 4800 bps. Examples of similar terminals in the MSS can be found in references [1-5] to Annex A. Such terminals may be:

- fixed, such as mounted along a roadway as part of a highway data collection system or mounted on a cabin windowsill as a satellite sound broadcasting receiver;
- transportable, such as being used as a data relay link at temporary construction sites or disaster-relief centers;
- mobile, such as being built into cars, trucks, trains, planes or ships as part of a satellite communications system;
- micro, such as being backpack-mounted for use when in remote areas;
- personal, such as being used as one would use a pager, cordless phone, or FM pocket sized radio receiver.

The market for these types of terminals is a substantial fraction of the market for all communications terminals under the assumption of continual progress toward universal personal ISDN. There is ample statistical evidence of continual growth in telephones and radio receivers per hundred inhabitants worldwide. Average global growth rates range from 5-10% annually. There are gains even in areas of high population growth. GSS terminals can be expected to satisfy a significant portion of demand for telecommunications terminals, especially for non-fixed applications.

Needs satisfied by universal ISDN generally, and GSS in particular, are:

- telephony, fixed and mobile
- data communications of variable speed including position reporting, data collection, and remote monitoring
- point to multi-point

Standardized data rates could be tied to the ISDN, 2B+D structure, if possible, in order to achieve universal ISDN compatibility.

3. PROPOSED DEFINITIONS

A general satellite service, properly defined, could best accommodate the requirements for new miniaturized satellite terminals with multi-service, multi-function capability which are expected to proliferate in the 1990s. The following definitions could be used:

General Satellite Service: A radiocommunication service:

- between earth stations at fixed, moving, or temporary locations, and one or more space stations;
- between earth stations by means of one or more space stations, including point-to-multipoint networks.

General Earth Station: An earth station in the general satellite service intended to be used while in motion, when temporarily halted, at a fixed location, or in a point-to-multipoint network.

General Satellite Space Station: A space station in the general satellite service.

4. CONCLUSION

Development of a new space services definition for a General Satellite Service, and its utilization in appropriate frequency bands, will permit the provision of a range of satellite services from a single satellite, thereby allowing exploitation of technological developments in user terminals and the meeting of user needs.

Annex A

SAMPLE SYSTEM DESIGN FOR A MULTI-SERVICE SATELLITE SERVING CONUS

1.0 INTRODUCTION AND OVERVIEW

A sample system design is presented in this Annex to illustrate the technical feasibility of a 20/30 GHz multi-service satellite system serving mobile, micro and personal terminals. The system design is extracted from the Personal Access Satellite System (PASS) research conducted by JPL [1,2]. Although PASS focuses on personal communications, it can be viewed as an integral part of a 20/30 GHz multi-service satellite system.

1.1 System Concept Description

The example system is a satellite-based communications system which extends satellite communications truly to the personal level. By exploiting the potential of high frequency bands (20/30 GHz), this system will provide users with diversified services, greater mobility, and freedom of access. With one or more high-power communications satellites covering an entire large service area, users can have access to a host of voice, video, and data applications anywhere within the service area. To support the various services, the system has to be capable of handling a range of data rates, starting from less than 100 bps for emergency and other low-rate services, to 4.8 kbps or higher for high-quality voice service, and up to 1 Mbps for video and high-rate computer file transfer.

1.2 Major Elements

The system contains a space segment, a ground segment, and different types of user equipment. Multi-beam frequency reuse technology will be employed to increase spectrum utility.

The ground segment includes a network management center (NMC), Tracking, Telemetry and Command (TT&C) stations, and supplier stations. The NMC and TT&C stations enable the system operator to control the operation of the system.

The system can support different types of user equipment, including: vehicular mobile terminals, aeronautical mobile terminals, basic personal terminals, micro terminals/enhanced personal terminals, and telemonitors. The vehicular mobile terminal consists of a tracking antenna, transceiver, modem, vocoder, handset, and other user interface equipment. This type of terminal can support voice, data, and fax. The aeronautical mobile terminal is similar to the vehicular mobile terminal with the exception that more than one airborne antenna may be needed to provide the needed coverage. The enhanced personal terminal is similar to today's VSAT terminals, except for the smaller antenna and the two-way high-rate capability. The enhanced personal terminal can have many applications by providing high-quality voice, high-reliability data

communications for direct computer file transfer, and low-rate video. The basic personal terminal is the most critical element in advancing satellite communications to the personal level. Equipped with a small directive antenna and a highly integrated transceiver/modem/vocoder, the basic personal terminal is very compact and hence provides users greater freedom and mobility than does the enhanced personal terminal. The basic personal terminal supports both voice and data communications. The telemonitor is used for remote monitoring and data collection. The satellite eirp will remain constant regardless of which type of user terminal is being supported while the data rate will be adjusted to be compatible with the particular terminal size.

1.3. Preferred Operating Frequency

Frequency bands near 20 and 30 GHz are particularly attractive as possible bands for a GSS service. Existing frequency bands below 20 GHz have a history of utilization making it very difficult to implement the GSS. Furthermore, those bands are unable to satisfy the anticipated demand for GSS due to capacity constraints.

1.4 Available Bandwidth

The wide bandwidths available near 20 and 30 GHz would accommodate the various services that a GSS could provide and would enable the use of powerful modulation and coding techniques (such as spread spectrum modulation combined with rate 1/3, constraint length 9 convolutional code) required to alleviate the power burden and reduce the complexity of both the spacecraft and the user terminals. Also, the expansion of spectrum available for mobile satellite applications could be beneficial.

1.5 Enabling the Development of Small Terminals

Small terminals are a key element of a GSS system. The laws of physics favors 20/30 GHz bands over lower frequency bands in terms of developing compact but directive user antennas. In addition, by taking advantage of MMIC techniques, the 20/30 GHz bands would allow the development of a highly integrated and miniaturized array antenna and transceiver unit.

1.6 Sharing Considerations

Due to the large number of terminals that could be served in a GSS, the wide service areas, and the mobile and portable nature of many of the user applications, sharing with the fixed and mobile terrestrial services does not appear feasible. There are frequency bands near 20 and 30 GHz that are allocated only to satellite services where sharing between a GSS and terrestrial services would not be necessary.

1.7 Existing Satellite Programs

There are existing programs which are aimed at developing 20/30 GHz satellite technologies. These programs include Europe's Olympus satellite, NASA's Advanced Communications Technology Satellite (ACTS) program, and NASA/JPL's ACTS Mobile Terminal Development. These programs offer an opportunity for an early demonstration of the GSS concept and technologies.

The ACTS program plans to carry out experiments which encompass both fixed, mobile and broadcast applications. The ACTS Mobile Terminal Development, which has the objectives of developing ground segment technologies at 20/30 GHz for mobile, micro, and personal terminals, is also of particular importance to the development of future 20/30 GHz GSS systems.

1.8 Bandwidth Requirements

A wide band will be required to fully realize the potential of small terminals and to support multi-service systems serving a user base of millions. A bandwidth in the neighborhood of 500 MHz in each direction (earth to space and space to earth) would be sufficient for both the user-satellite and feeder links.

1.9 Performance Criteria for a GSS

To provide good quality voice and reliable data communications, a GSS system should meet the following performance criteria:

- Bit Error Rate

Voice Communications < 1.0E-3

Data Communications < 1.0E-5

- Link Availability

Moderate link availability. A small terminal system would be able to provide about 98% availability when averaged over a year for general purpose communications. Higher availability for business and safety related communications would require the use of larger earth terminal antennas and/or the use of additional rain attenuation compensation techniques.

1.10 Interference Protection Criteria

The interference protection criterion used in determining the inter system and intrasystem

sharing feasibility is such that the interference will not degrade the system noise temperature of the wanted system by more than 10%. This criterion is the same used in [3] and has been adopted to determine the sharing feasibility for the mobile satellite systems. This criterion applies to percentages of time greater than 20%. Interference may exceed the stated level for percentages of time less than 0.2% of the time.

1.11 Sharing Studies

Both a GSS and the FSS spacecraft will utilize spot beam technology at 20 and 30 GHz in order to enable the use of small earth terminals. High rain attenuation at these frequencies will mean that both services will probably implement systems to serve applications having moderate availability requirements. The systems in both services are likely to be fairly homogeneous. In many cases, such as ACTS, the same satellite will provide both fixed and mobile services. All of these factors should result in consideration of sharing techniques that would not be useful at lower frequencies.

Spot beam technology will enable frequency reuse as one mode of sharing the orbit/spectrum resource. The ACTS satellite, for example, will provide three types of spot beams: stationary, electronically hopping, and mechanically steered. The half power beam width for both the stationary and the hopping beams is approximately 0.3 degrees. The feasibility of implementing spot beams creates a major difference when considering the feasibility of sharing at 20 and 30 GHz compared to sharing between satellites in lower frequency bands.

Another factor which will enhance sharing at 20 and 30 GHz compared to lower frequencies is the relative ease of providing significant gain in the earth terminal antennas. Three types of user antennas are anticipated: low-gain antennas with 4-8 dBi gain; medium gain antennas with 10-16 dBi gain; and high-gain antennas with 18 dBi or more gain. The use of high-gain antennas is expected to predominate and for this case interference discrimination is available from both spacecraft and earth terminal antennas. This discrimination can be used to facilitate orbit reuse. For earth terminals having low gain antennas it is probable that processing gain achieved through use of spread spectrum will be needed to achieve efficient use of the orbit/spectrum resource.

Frequency sharing techniques among different mobile satellite systems in the 1.5/1.6 GHz bands have been examined in detail in [8]. Some of the same approaches can be applied to determine the sharing feasibility between GSS systems (intrasystem), and between GSS and FSS (intersystem).

Sharing is generally feasible for systems employing high-gain user antennas (18 dBi or more). An orbital separation of 20-40 degrees, coupled with polarization diversity, would be sufficient to reduce interference to an acceptable level for a user antenna gain of 18 dBi even when the two systems operate co-channel, serve a common service area, and employ the same modulation type. The Annex examines this case in more detail.

Frequency reuse achievable through use of spot beam technology and the benefits derived from use of different modulation schemes will, in practice, permit reduction of orbital separation below 20 degrees and, of course, use of higher gain antennas will result in marked decrease in the needed orbital separation.

2.0 SYSTEM ARCHITECTURE

The 20/30 GHz multi-service satellite system contains a space segment, a network management center, supplier stations, and a number of user terminals. Services are facilitated by properly linking the users and the appropriate service provider. To achieve operational simplicity, the sample system design utilizes fixed multibeam to provide simultaneous, continuous coverage to users in the service area, i.e., CONUS. In addition to the spotbeams, a single CONUS beam is employed to complete the user-to-supplier and/or supplier-to-user links.

Access to the system by the suppliers and the users will be provided by means of a hybrid TDMA/FDMA (Time Division Multiple Access/Frequency Division Multiple Access) scheme. In the forward direction, suppliers gain access to the system using TDMA. In the return direction, access to the system by users is provided using narrow band single carrier per channel (SCPC), frequency division, demand assigned multiple access (DAMA).

The salient features of the design are tabulated in Table 1.

3.0 SATELLITE AND USER TERMINAL DESIGNS

The satellite employs both CONUS coverage antenna and spot beam antennas, as mentioned above. There is one CONUS antenna which will be used for the downlink and uplink signals to and from the supplier stations, network management center, and the TT&C station. The spot beam antennas will be used for the user's uplink and downlink. There are two spot beam antennas, with diameters of 2m and 3m for transmit and receive, respectively. These antennas produce 142 spot beams covering the service area. The spot beam antennas have a gain of 52.5 dBi and 3 dB beam width of 0.35 degrees. The corresponding receive G/T is 23.4 dB/K, and the eirp is 55 dBW. The CONUS beam receiver G/T is -1.2 dB/K, and the transmitter eirp is 40 dBW. The key features of the satellite are summarized in Table 2.

There are five types of user terminals: Vehicular Mobile Terminals (VMT), Aeronautical Mobile Terminals (AMT), Basic Personal Terminals (BPT), Micro Terminals/Enhanced Personal Terminals (EPT), and Telemonitors. The VMTs consist of a tracking antenna, transceiver, modem, vocoder, handset, and other user interface equipment. The mobile terminal is capable of supporting two-way voice and data communications as well as low-rate broadcasting. The antenna gain ranges from 20 dBi and higher.

The AMTs are similar to the VMTs with the exception that more than one airborne antenna may be needed to provide the needed coverage.

The BPTs, which represent the major technological challenge, will be equipped with a tracking antenna and will be capable of supporting voice and data services at a rate not exceeding 4.8 kbps under normal operating condition, i.e., no rain. This type of terminals are required to have an antenna gain of 23 dBi at the transmit frequency and 19 dBi at the receive frequency, a variable rate modem, a 1-watt transmitter, and other application-dependent components. The variable rate modem is to combat rain attenuation. The BPTs are intended for mobile applications, i.e., to be carried around by the user. The key design requirements of the BPTs are given in Table 3, where a phased array antenna has been assumed for its compactness, although other concepts are applicable.

The EPTs (or Micro Terminals) are similar to today's VSAT terminals, except for the smaller antenna and the two-way high-rate capability. With an antenna of 0.33 m or less in diameter, the EPTs can have many applications by providing high-quality voice, high-reliability data communications for direct computer file transfer, and low-rate video. These terminals are not intended to be mobile. As such, they do not have to be very compact and many antenna concepts are applicable [2]. The sample design assumes a dish type of antenna with a gain of 32.5 dB at 20 GHz and 36.0 dB at 30 GHz. Table 4 summarizes the design requirements for this type of terminal.

The telemonitors are used for remote monitoring and data collection.

4.0 LINK BUDGETS

A detailed link budget is shown in Table 5 for the return link. This budget is for voice communications using a 4.8-kbps digital voice. This link is designed to provide $1.0\text{E-}3$ bit-error rate (BER) with 3 dB link margin in clear weather. The data rate will be reduced to 2.4 Kbps during rain. This will provide a sufficient margin to combat rain for an estimated 98% of the time at the expense of a slightly reduced voice quality. The $1.0\text{E-}3$ BER is sufficient for providing good quality voice. Data messages generally require a lower BER in order to minimize packet errors. Additional FEC coding therefore will be needed for data messages and will increase the overhead accordingly.

Table 6 is a similar link budget for the forward link. Although the signals in the forward direction are time-division multiplexed and normally operate at 100 kbps, the link budget was performed for a hypothetical voice channel operating at 4.8 kbps. Similar to the return link, the forward link is sized to provide a 3 dB margin during clear weather. Reducing the data rate from 4.8 kbps to 2.4 kbps during rain will be sufficient to compensate for rain effects for 98% of the time. Due to the TDM/TDMA architecture, the forward link is designed to provide $1.0\text{E-}5$ BER, which is adequate for voice and data

communications.

5.0 RAIN ATTENUATION AND COMPENSATION

Heavy rain can result in severe signal attenuation. In addition, it can increase the receiving system noise temperature, resulting in further performance degradation. The sample design employs a combination of uplink power control and an adjustable data rate to combat rain attenuation. Uplink power control is applied only to the supplier-to-satellite link. When increased uplink power from the supplier fails to fully compensate for rain degradation, the data rate will be reduced to close the link. This scheme will provide an estimated 98% link availability [2]. (It is noted that there are techniques, such as the use of a processing satellite, that alleviate this problem at the expense of increased satellite complexity and mass.)

6.0 FREQUENCY PLAN

The uplink frequency is 30 GHz and the downlink frequency is 20 GHz. The available uplink and downlink spectra are each divided into two parts for the CONUS beams (feeder links) and the spot beams. To increase the spectrum utility, the spectrum assigned for the spot beams is reused 16 times. There is no reuse for the CONUS beam.

7.0 SYSTEM CAPACITY

Economic viability is a very important factor that will determine whether a multi-service satellite system will be implemented commercially. While there are many factors affecting the system's economic viability, the significance of system capacity cannot be overstated. Studies have shown that large-capacity systems benefit from economy of scales. Using a high-power commercial satellite bus having a GTO mass of 7500 lbs, the estimated system capacity is equivalent to 7500 duplex voice channels. The capacity is based on the assumption that all user terminals are BPTs, and that all traffic is voice, with a voice activity factor of 0.35. The actual capacity depends on the voice and data traffic mix and user equipment mix (i.e., AMT, VMT, BPT, EPT and Telemonitors).

The number of users who can be supported is a function of the traffic model, which is characterized by parameters such as traffic mix, grade of service, and offered traffic. Assuming a typical traffic scenario and including users of EPTs and telemonitors, the number of users who can be served can easily exceed one million.

8.0 SHARING ANALYSIS

This section examines the sharing of two multi-service satellite systems which have a common service area, operate cochannel, and use the same modulation type. This is a worst case condition for a multi-service satellite operating in the 20 and 30 GHz frequency bands because no account has been taken of the sharing advantages available at these

frequencies from use of satellite spot beam technology and from use of different modulation types. Only the discrimination due to the earth terminal antenna pattern and from polarization diversity are considered.

Frequency sharing techniques among different mobile satellite systems operating in the 1.5/1.6 GHz bands have been examined in detailed in [8]. The same approach is applied to multi-service satellites to determine the sharing feasibility between multi-service satellite systems. The interference protection criterion used in [8] is such that the interference will not degrade the system noise temperature of the wanted system by more than 10%.

The required satellite separation has been estimated using two antenna radiation pattern models described in [8]. These models are basically the same as the Reference Radiation Pattern described in a CCIR report [CCIR Mobile Services, 1982], with modifications to include (1) 4 dB cross-polarization discrimination, and (2) better sidelobe performance. Figures 1 and 2 show the required satellite separation as a function of the wanted user antenna gain for the forward link using the "REF+7 DB" and "REF+11 DB" radiation patterns respectively. Figure 3 shows the satellite separation for the return direction. As indicated by these figures, a separation of 20-40 degrees is sufficient for systems using high-gain antennas. A larger separation will be needed for systems using medium-gain antennas.

9. REFERENCES

- [1] "INMARSAT Standard M Draft Specifications", London, U.K., 1989
- [2] "Personal Access Satellite System (PASS) Study, Fiscal Year 1989 Results," M. K. Sue, Editor, JPL Report D-7382, May 1990.
- [3] "Understanding Radio Determination Satellite Service" page 9, GEOSTAR Corp., 1988.
- [4] New York Times June 26, 1990 page D7
- [5] Application of Radio Satellite Corporation to the FCC, May 25, 1990
- [6] United Nations Educational, Scientific, and Cultural Organization Statistical Yearbook, Section 10 (Communications) 1989
- [7] "A 20/30 GHZ Personal Access Satellite System Study," M. K. Sue, A. Vaisnys, and W. Rafferty, Proceedings of the 38th IEEE Vehicular Technology Conference, Philadelphia, June 15-17, 1988.
- [8] "Inter System Technical and Operational Sharing Considerations in the Mobile Satellite Services," V. Jamnejad, J. King, E. Reinhart, M. Sue, and D. Swearingen, NTIA TN-88-3, February 1988.

Table 1

Salient Features of the Sample System Design

OPERATING FREQUENCY	
UPLINK	30 GHz
DOWNLINK	20 GHz
COVERAGE CONCEPT	
SAT/SUPPLIERS	CONUS BEAM
SAT/USERS	142 SPOTBEAMS
MULTIPLE ACCESS	
SUPPLIERS	TDMA
USERS	FDMA
GENERIC SERVICES	VOICE AND DATA
DATA RATES	
FORWARD (NORMAL)	100 kbps (BPT) 300 kbps (EPT)
RETURN (NORMAL)	4.8 kbps (BPT)
RAIN COMPENSATION	
FORWARD	UPLINK POWER CONTROL & VARIABLE DATA RATE
RETURN	VARIABLE DATA RATE
LINK AVAILABILITY	98%
INTER BEAM POWER MANAGEMENT	9-BEAM POWER MANAGEMENT
FREQUENCY REUSE CAPABILITY	16 TIMES (SPOT BEAMS)
SYSTEM CAPACITY*	
RAW DUPLEX CHANNELS	2800 (100% DUTY CYCLE), OR
DUPLEX VOICE CHANNELS	7500 (VOX=35%)

* System capacity is given in terms of the number of equivalent channels at 4.8 kbps each assuming that all user terminals are BPTs.

Table 2
Summary of the Satellite Design

SPOT BEAM	
ANTENNA SIZE (TRANSMIT)	3 m
(RECEIVE)	2 m
NUMBER OF SPOT BEAMS	142
ANTENNA GAIN	52.5 dBi
ANTENNA BEAM WIDTH	0.35 deg
SYSTEM G/T	23.4 dB/K
AVERAGE EIRP/B EAM	58.7 dBW
CONUS BEAM	
ANTENNA GAIN	27.0 dB
ANTENNA BEAM WIDTH	7.7 deg
SYSTEM G/T	- 1.2 dB/K
EIRP	46.1 dBW
SATELLITE MASS (GTO)	7500 lb
SATELLITE POWER (EOL)	4.0 kW

Table 3
Design Requirements for the BPT

ANTENNA GAIN @20 GHz	19.3 dBi
ANTENNA GAIN @30 GHz	22.8 dBi
ANTENNA TRACKING/COVERAGE	
CAPABILITY	
AZIMUTH	360.0 deg
ELEVATION	15-60 deg
RECEIVE G/T	-9.0 dB/K
TRANSMIT POWER	0.17 W
NORMAL DATA RATE	
RECEIVE	100 kbps
TRANSMIT	4.8 kbps
OTHER REQUIREMENTS	
SIZE	HAND-HELD
MODEM	VARIABLE RATE

Table 4

Design Requirements for the EPT

ANTENNA GAIN @20 GHz	32.5 dBi
ANTENNA GAIN @30 GHZ	36.0 dBi
ANTENNA TRACKING REQUIREMENT	NONE
RECEIVE G/T	4.2 dB/K
TRANSMIT POWER	0.02 W/4.8 kbps
	WITH POWER CONTROL
NORMAL DATA RATE	
RECEIVE	300 kbps
TRANSMIT	4.8 kbps AND UP
OTHER REQUIRED CAPABILITIES	
MODEM	VARIABLE RATE MODEM

FIGURE 5. RETURN LINK BUDGET FOR BPSs
(4.8 Kbps VOICE, CLEAR SKY, 1.0E-3 BER)

V891109

		USER TO SAT					SAT TO SUPPLIER				
		FAV		ADV	VAR		FAV		ADV	VAR	
	'PDF	DESIGN	TOL	TOL	MEAN (X.01)		DESIGN	TOL	TOL	MEAN (X.01)	
TRANSMITTER PARAMETERS											
1)XMIT POWER,DBW	TRI	-7.80	.3	.3	-7.80	1.50	-15.00	.30	.30	-15.00	1.50
2)XMIT CIRCUIT LOSS,DB	REC	-.50	.1	.4	-.65	2.08	-.50	.10	.40	-.65	2.08
3)ANTENNA GAIN,DBI	TRI	22.80	.5	.5	22.80	4.17	26.90	.50	.50	26.90	4.17
4)EIRP,DBW ((1)+(2)+(3))		14.50			14.35		11.40			11.25	
5)POINTING LOSS,DB	TRI	-1.55	.68	.88	-1.62	10.20	.00	.00	.00	.00	.00
PATH PARAMETERS											
6)SPACE LOSS,DB		-214.03			-214.03		-210.51			-210.51	
(FREQUENCY,GHZ/GHZ =		30.00					20)
(RANG= 40000 KM)											
7a)ATMOSPHERIC ATTN, DB	TRI	-.70	.50	.50	-.70	4.17	-.90	.40	.40	-.90	2.67
7b)RAIN ATTN, DB	TRI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8)E.O.B.LOSS,DB	TRI	-4.00	1	1	-4.00	4.17	-3.00	.50	.50	-3.00	4.17
9)MULTIPATH LOSS,DB	GAU	.00	0	0	.00	.00	.00	.00	.00	.00	.00
10)SHADOWING LOSS,DB	DEL	.00	0	0	.00		.00	.00	.00	.00	
RECEIVER PARAMETERS											
11)POLARIZATION LOSS,DB	TRI	-.50	0	0	-.50	.67	-.50	.20	.20	-.50	.67
12)ANTENNA GAIN,DBI	TRI	52.50	1	1	52.50	16.67	57.50	1.00	1.00	57.50	16.67
13)POINTING LOSS,DB	TRI	-1.23	0	0	-1.23	.00	-.09	.02	.02	-.09	.01
14)RECEIVED SIGNAL POWER,DBW		-155.01			-155.23		-146.10			-146.25	
(SUM OF LINES 4 - 13)											
15)SYSTEM TEMPERATURE,DBK	GAU	29.07	.30	.61			27.15	.62	.95		
(CIRCUIT LOSS,DB =		-1.50	0	0			-1.00	.10	.40)
(RCVR N.F. ,DB =		3.00	0	0			3.00	.20	.20)
(EXTERNAL ANT TEMP,K =		280.00	0	0			81	20	18)
(INTERNAL ANT TEMP,K =		.00	0	0			.00	0	0		
(RAIN INDUCED TEMP,K =		.00	0	0			.00	0	0		
16)RECEIVED NO,DBW/HZ	GAU	-199.53	.30	.61	-199.38	2.30	-201.45	.62	.95	-201.28	6.78
((15)-228.6 DBW/HZ)											
(BANDWIDTH,KHZ =		20.00					20.00)
CHANNEL PERFORMANCE											
17)RCVD C/NO,DB-HZ ((14)-(16))		44.52			44.15		55.34			55.03	
18)EFFECTIVE C/NO,DB-HZ		44.50			44.13		55.16			54.86	
(OVERALL C/I,DB =	GAU	26.00	1	1	26.00	11	26.00	1.00	1.00	26.00	11.11)
(INTERBEAM ISOLATION =		26.00	1.00	1.00			99.00	1.00	1.00	99.00)
(INTERSAT. ISOLATION =		99.00	.50	.50			99.00	.50	.50	99.00)
(INTERMOD ISOLATION =	TRI	99.00	1.00	1.00			26.00	1.00	1.00	26.00)
(TURNAROUND C/NO =	GAU						44.50			44.13	57.03)
(NO(UP)/NO(REQUIRED) =		.75		.25			.75)
19) END-TO-END C/NO, DB-HZ							43.91			43.78	
20) MODEM/RADIO LOSS, DB=	TRI	.00			.00		-1.00	.30	.30	-1.00	1.50)
21)REQUIRED C/NO,DB-HZ		41.06			41.06		39.81			39.81	
(REQUIRED EB/NO,DB							3.00)

22)PERFORMANCE MARGIN,DB		3.44			3.07	.76	3.09			2.97	1.04
((19)+(20)-(21))					(1 SIG)					(1 SIG)	

FIGURE 6. FORWARD LINK BUDGET FOR BPTs
(4.8 Kbps VOICE/DATA, CLEAR SKY, 1.0E-5 BER)

V891109

		S U P P L I E R T O S A T					S A T T O U S E R				
		FAV		ADV	VAR		FAV		ADV	VAR	
	PDF	DESIGN	TOL	TOL	MEAN (X.01)		DESIGN	TOL	TOL	MEAN (X.01)	
TRANSMITTER PARAMETERS											
1)XMIT POWER,DBW	TRI	-3.00	.30	.30	-3.00	1.50	-6.80	.30	.30	-6.80	1.50
2)XMIT CIRCUIT LOSS,DB	REC	-1.00	.10	.40	-1.15	2.08	-1.50	.10	.40	-1.65	2.08
3)ANTENNA GAIN,DBI	TRI	57.50	1.00	1.00	57.50	16.67	52.50	1.00	1.00	52.50	16.67
4)EIRP,DBW ((1)+(2)+(3))		53.50			53.35		44.20			44.05	
5)POINTING LOSS,DB	TRI	-.09	.02	.02	-.09	.01	-1.23	.05	.05	-1.23	.04
PATH PARAMETERS											
6)SPACE LOSS,DB		-214.03			-214.03		-210.51			-210.51	
(FREQUENCY,GHZ/GHZ =		30.00					20)
(RANG= 40000 KM)											
7a)ATMOSPHERIC ATTN, DB	TRI	-.70	.50	.50	-.70	4.17	-.90	.40	.40	-.90	2.67
7b)RAIN ATTN, DB	TRI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8)E.O.B.LOSS,DB	TRI	-3.00	.50	.50	-3.00	4.17	-4.00	.50	.50	-4.00	4.17
9)MULTIPATH LOSS,DB	GAU	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
10)SHADOWING LOSS,DB	DEL	.00	.00	.00	.00		.00	.00	.00	.00	
RECEIVER PARAMETERS											
11)POLARIZATION LOSS,DB	TRI	-.50	.20	.20	-.50	.67	-.50	.20	.20	-.50	.67
12)ANTENNA GAIN,DBI	TRI	26.90	.50	.50	26.90	4.17	19.30	.50	.50	19.30	4.17
13)POINTING LOSS,DB	TRI	.00	.00	.00	.00	.00	-.70	.29	.40	-.74	2.00
14)RECEIVED SIGNAL POWER,DBW		-137.92			-138.07		-154.34			-154.53	
(SUM OF LINES 4 - 13)											
15)SYSTEM TEMPERATURE,DBK	GAU	28.06	.30	.61			28.23	.60	.86		
(CIRCUIT LOSS,DB =		-.50	.10	.40			-.50	.10	.40)
(RCVR N.F. ,DB =		3.00	.20	.20			3.50	.20	.20)
(EXTERNAL ANT TEMP,K =		280.00	0	0			107	20	18)
(INTERNAL ANT TEMP,K =		.00	0	0			119.60	18	19		
(RAIN INDUCED TEMP,K =		.00	0	0			.00	0	0		
16)RECEIVED NO,DBW/HZ	GAU	-200.54	.30	.61	-200.39	2.32	-200.37	.60	.86	-200.24	5.91
((15)-228.6 DBW/HZ)											
(BANDWIDTH,KHZ =		20.00					20.00)
CHANNEL PERFORMANCE											
17)RCVD C/NO,DB-HZ ((14)-(16))		62.62			62.32		46.03			45.71	
18)EFFECTIVE C/NO,DB-HZ		62.24			61.96		45.98			45.67	
(OVERALL C/I,DB =	GAU						22.99	1.00	1.00	22.99	11.11)
(INTERBEAM ISOLATION =							26.00	1.00	1.00	26.00)
(INTERSAT. ISOLATION =							99.00	.50	.50	99.00)
(INTERMOD ISOLATION =	TRI	30.00	1.00	1.00	30.00	16.67	26.00	1.00	1.00	26.00)
(TURNAROUND C/NO =	GAU						62.24			61.96	52.41)
(NO(UP))/NO(REQUIRED) =		.10					.10)
19) END-TO-END C/NO, DB-HZ							45.83			45.57	
20) MODEM/RADIO LOSS, DB=	TRI	.00			.00		-1.50	.30	.30	-1.50	1.50)
21)REQUIRED C/NO,DB-HZ		51.31			51.31		41.31			41.31	
(REQUIRED EB/NO,DB							4.50)

22)PERFORMANCE MARGIN,DB		10.93			10.65	.72	3.02			2.76	1.02
((19)+(20)-(21))						(1 SIG)					(1 SIG)

FIG. 1 REQUIRED SATELLITE SPACING (FORWARD LINK, INTRASYSTEM)

ANTENNA PATTERN: REF +7 DB

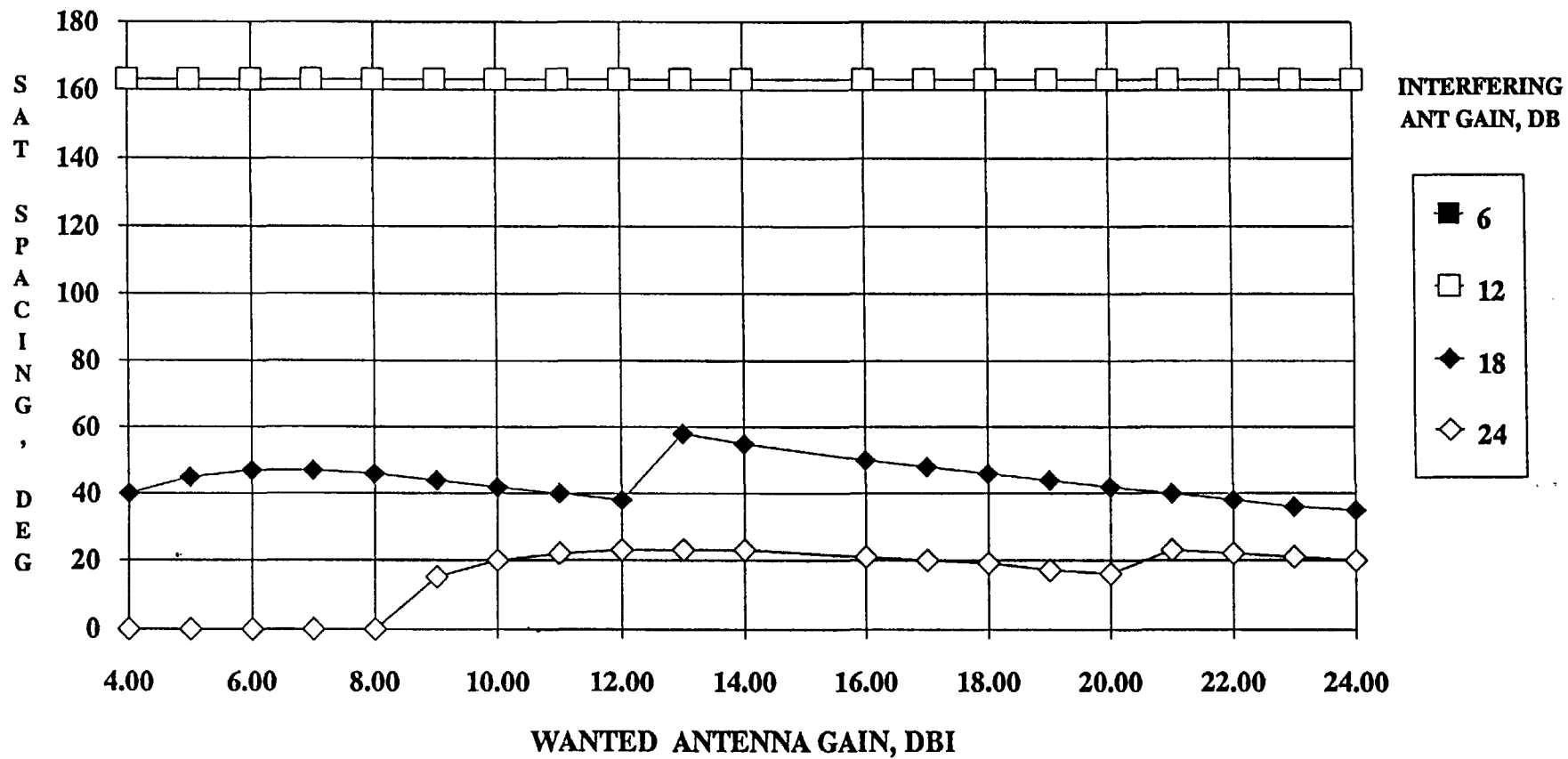


FIG. 2 REQUIRED SATELLITE SPACING (FORWARD LINK, INTRASYSTEM)

ANTENNA PATTERN: REF + 11 DB

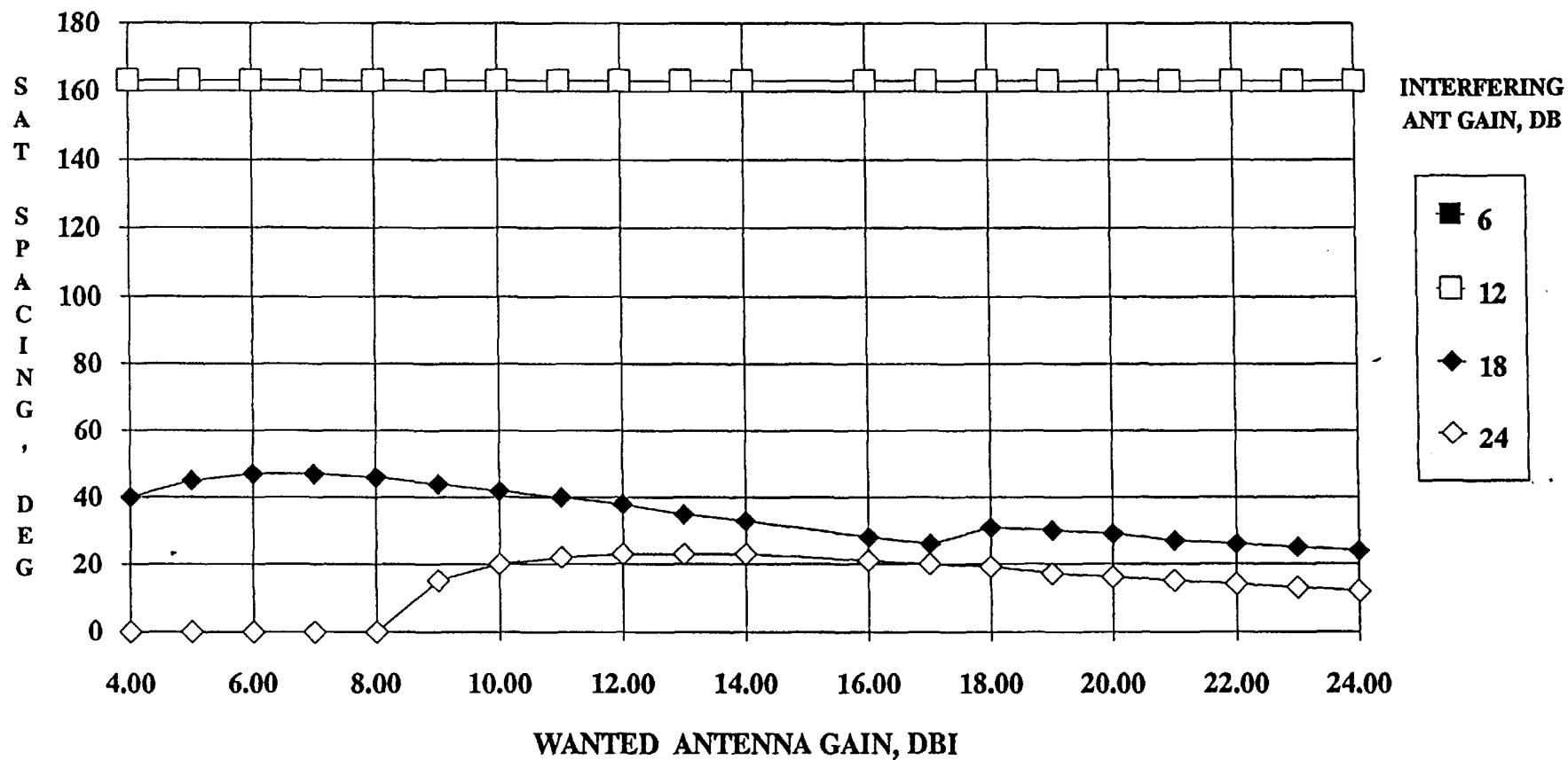
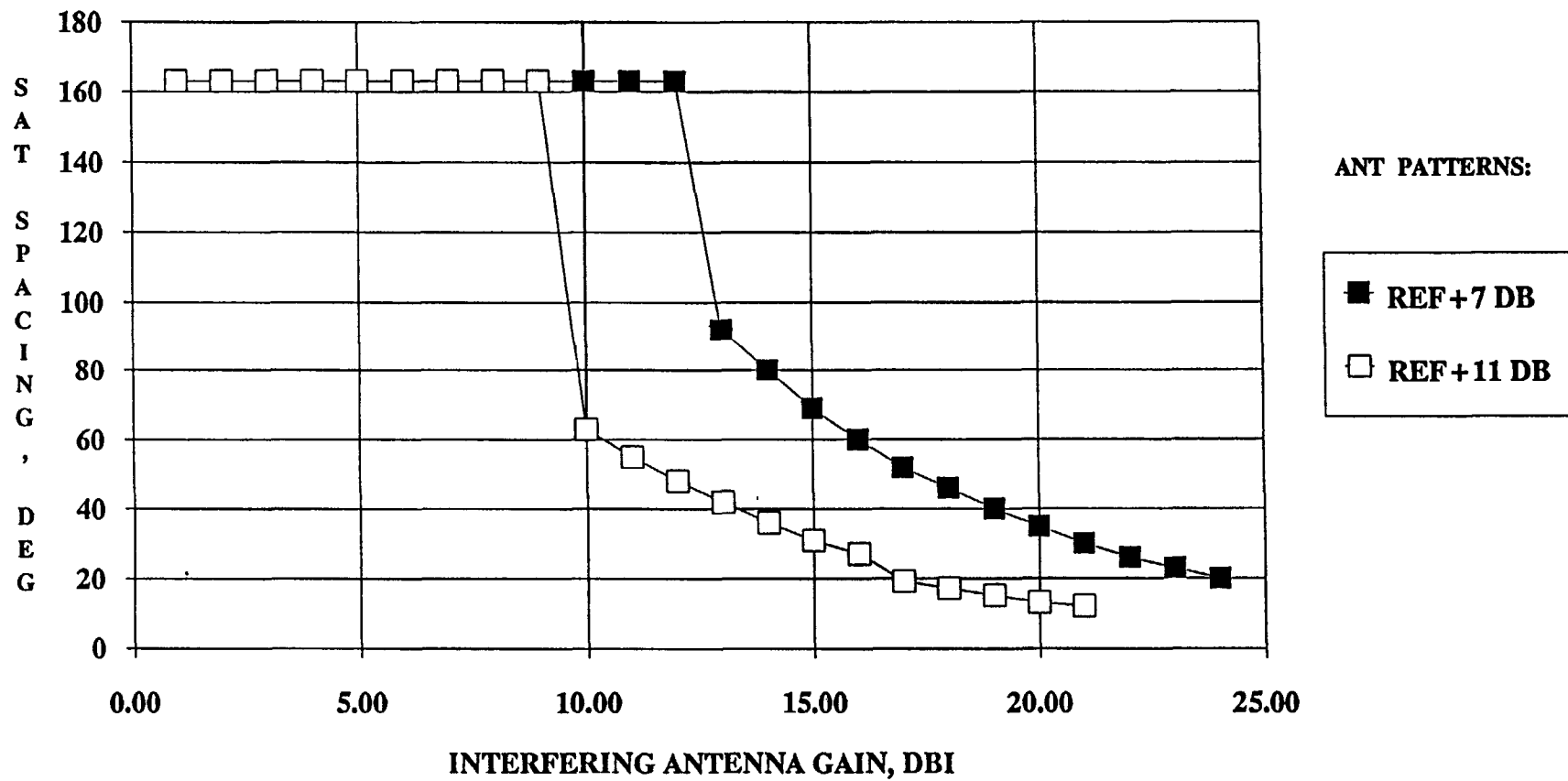


FIG. 3 REQUIRED SATELLITE SPACING (RETURN LINK, INTRASYSTEM)



IWG-3/30 (Rev 1)

FCC MAIL SECTION

COMMENTS ON THE SECOND NOI WITH RESPECT TO MOBILE-SATELLITE SERVICE NEAR 20/30 GHZ AND TO GENERAL SATELLITE SERVICE

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1. INTRODUCTION

Federal Communications Commission
Office of the Secretary

The FCC's WARC-92 Industry Advisory Committee included in its July, 1990 submission to the FCC a proposal that the United States seek reallocation of a portion of the 20/30 GHz frequency band to a new General Satellite Service. Within such a service, satellite communications would be provided to fixed or mobile terminals and operations would be governed by technical characteristics rather than service definitions. The specific proposal is that the 19.7-20.2 GHz (space-to-earth) and 29.5-30.0 GHz earth-to-space) bands be reallocated to the General Satellite Service. The current allocation in these bands is for fixed-satellite service on a primary basis and mobile-satellite service on a secondary basis.

The need to improve the allocation status of mobile-satellite services near 20/30 GHz is recognized in the FCC's second notice of inquiry and the draft U.S. proposals published with the NOI include primary allocations for the mobile-satellite service at 19.7-20.2 GHz and at 29.5-30.0 GHz.

An alternative means to achieving the objectives of upgrading the mobile-satellite service to primary at 20/30 GHz would be to establish a new general satellite service. This approach also is discussed in the NOI and the FCC requests comments on it.

In a related matter, the FCC asks for comments, in paragraph 143, on the practicality of relocating the fixed-satellite service allocation from 19.7-20.2 GHz to 22.5-23 GHz.

2. DISCUSSION AND RESPONSE TO FCC'S SECOND NOI

Allocation to a new General-Satellite Service would have advantages over upgrading the Mobile-Satellite Service to primary

As technology evolves toward digital satellite communications and earth stations become increasingly smaller, allocations based on satellite service definitions are artificial. Such artificial distinctions may retard development of new frequency bands such as the Ka-band. The reallocation of a currently little-used band is timely as it will encourage the development of innovative uses of that band on a near-term basis.

It is the opinion of IWG-3 that satellites in the 20/30 GHz bands will operate with new, miniaturized digital satellite terminals capable of fixed, mobile, and point-to-multi-point applications. The group has examined both an upgrade of the mobile-satellite service to primary allocation status and the alternative of establishment of a new general-satellite service to determine which approach would better serve the needs of operators of the satellites that are foreseen for 20/30 GHz.

An upgrade of secondary mobile satellite allocations at 20/30 GHz to primary clearly could satisfy some of the needs of satellite users. However, such an upgrade would leave several other requirements unsatisfied, including: (1) coordination-free operation of mobile and fixed terminals, and (2) complete flexibility for satellite operators to provide services in accordance with changing market demand.

When two different services share a frequency band on a primary basis, the first service within which a space station has completed the IFRB coordination process enjoys protection from interference from stations subsequently implemented in the second service. If stations are coordinated for both services simultaneously, some of the needs of users for multi-application operations can be satisfied. However, if either fixed or mobile stations are coordinated first, then the second application to be coordinated will be de facto secondary, and perhaps unable to fulfill its full development potential.

Upgrading the Mobile-Satellite Service (MSS) to co-primary with the Fixed-Satellite Service (FSS) at 20/30 GHz will not provide satellite operators with the full marketing flexibility they require in the 1990's. Satellite operators need the flexibility to provide any type of satellite service in order to reduce business risks. The heavy up-front investment in satellite systems, and the frequent delays in launch schedules, make satellite financiers wary of narrowly defined capabilities such as FSS or MSS. The General Satellite Service (GSS) concept enables a satellite operator to serve whatever user terminal market that arises. This is the very kind of flexibility that satellite financiers prefer. Co-primary allocations imply a need for inter-service coordination, which is contrary to the full flexibility needed in the satellite industry of the 1990's.

In addition to the foregoing shortcomings which would derive from a proposal to upgrade the mobile satellite allocations at 19.7-20.2 GHz and 29.5-30 GHz to primary, it is necessary to consider the possible reception of the proposal at the 1992 WARC. The WARC agenda clearly makes it competent to consider new space services above 20 GHz but some administrations may argue that it does not permit upgrading of the allocation status of an existing radio service. Therefore, there is another advantage to a proposal for establishment of a GSS.

The Ka-band currently is used for broadcasting-type service in Japan and for fixed-satellite service in Europe. Within the United States, NASA is developing the Advanced Communications Technology Satellite (ACTS) which will conduct experiments encompassing fixed, mobile, and broadcasting applications. A private company, Norris Satellite Communications, Inc. has applied to the FCC to construct two and launch and operate a satellite operating in the 20/30 GHz band. See, Applications File Nos. 54-DSS-P/L-90 and 55-DSS-P-90. Norris has also asked the Commission to reallocate a portion of the Ka-band to a General Satellite Service (RM-7511).

Over the past few years, the Commission has taken a more flexible approach to spectrum allocation and use.

The Commission has recognized the efficiency and prudence in equipping satellites to provide different services, e.g., fixed and radiodetermination satellite service (RDSS), that would be offered by two unrelated enterprises.¹ Similarly, the Commission has authorized a single corporation to deliver multiple services via a single satellite, such as Geostar's provision of RDSS and messaging services via the same satellite.²

The Commission and the United States in other instances have supported the adoption of generic satellite services as promoting efficient use of the spectrum-orbit resource. In 1987 the U.S. proposed amending the International Table of Allocations to establish a generic allocation for mobile satellite service in the L-band, incorporating maritime, aeronautical and land mobile applications.³ Such a generic allocation, the

¹ See GTE Spacenet Corp., 2 FCC Rcd. 5312 (rel. Aug. 28, 1987) approving modification of GSTAR IV Fixed Satellite Service construction permit to add a transmit/receive payload in the Radiodetermination Satellite Service.

"By including the transmit/receive RDSS payload in the GSTAR IV satellite, the introduction of two-way radiodetermination service will be accelerated by several years We . . . find that there is no significant adverse impact on fixed-satellite service in the 12/14 GHz band." *Id.* at 5313. The Commission also held that GTE Spacenet "will be able to fulfill its authorized [Fixed Satellite Service licensed] purpose" even with the addition of an RDSS transmit/receive package. *Id.*

² See Geostar Corp., Mimeo No. 6144 (rel. Aug. 7, 1986) authorizing construction, launch and operation of 3 satellites in the Radiodetermination Satellite Service, applications modified to expand bandwidth authorized for "ancillary" Fixed Satellite Services, sub nom. Geostar Positioning Corp., 5 FCC Rcd. 1658 (released March 14, 1990).

The Commission also has allowed a mobile satellite service provider to use feeder link frequencies allocated to the Fixed Satellite Service. Amendment of Parts 2, 22, and 25 of the Commission's Rules to Allocate Spectrum for and to Establish Other Rules and Policies Pertaining to the Use of Radio Frequencies in a Land Mobile Satellite Service for the Provision of Various Common Carrier Services, CC Docket No. 84-1234, Order on Reconsideration, 4 FCC Rcd. 6041, 6053 (1989).

³ Preparations for an International Telecommunications Union World Administrative Radio Conference for the Mobile Services, Gen. Docket No. 84-607, Report and Order, 2 FCC Rcd. 821 (rel. Feb. 13, 1987). The proposal for a generic mobile satellite service allocation in the L-band "seeks to attain maximum flexibility and competition." *Id.*

Commission recognizes, promotes user and carrier flexibility and the opportunity for satellites to provide capacity for a number of previously mutually exclusive services.

In its Second NOI, the Commission again proposes a generic approach for mobile satellite service allocations in the L-band. Indications are that this approach has gained greater acceptability among other administrations as well. In addition, in the Second NOI, the Commission proposes sharing between the Radiodetermination Satellite Service and the Mobile Satellite Service.

While there are technical and operational challenges posed by multi-function satellites, these problems are not insoluble.

Future satellite services are likely to be delivered from space platforms where various services are aggregated in a condominium configuration. The Commission's creation of a General Satellite Service would recognize that less service specific classifications better satisfy consumer requirements and enable operators to exploit technological economies of scale and spreading of risk.

Moving the Fixed-Satellite Service allocation from 19.7-20.2 GHz to 22.5-23 GHz would not be desirable

The Commission, in paragraph 143 of its second NOI, raises the possibility that the FSS in the 19.7-20.2 GHz band be moved to 22.5-23 GHz where sharing

See also, Public Notice, "Implementation of the 1987 WARC For Mobile Services," 3 FCC Rcd. 6780 (rel. Nov. 23, 1988), in which the Commission states:

By reallocating [L-band] spectrum . . . to be shared both primarily and secondarily among the land, aeronautical and maritime mobile satellite services, the U.S. was partially successful in establishing spectrum for more general mobile satellite service (land, aeronautical and maritime). However, the Conference did not allocate the spectrum to a generic MSS service as proposed and the allocation for shared service was less than sought. Because the mobile satellite service was unduly restricted, the U.S. took a formal reservation to use the L-band spectrum in the way most appropriate to satisfy its MSS requirements while recognizing the priority of AMSS(R) and maritime safety communications.